OBSERVATIONS ON GROWTH AND DIET OF
ARGIOPE AURANTIA LUCAS (ARANEIDAE)
IN A SUCCESSIONAL HABITAT

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ABSTRACT

A population of *Argiope aurantia* Lucas was sampled through a growing season in a swamp habitat of the Savannah River Plant near Aiken, South Carolina. Observations and physical data showed that immature females increased web area dramatically as the male population began to reach maturity. This change in web area paralleled a change in diet composition from smaller zygopterans to larger bodied libellulid dragonflies. A second shift in diet to pollinating Apidae occurred as females were initiating egg case production and was associated with blooming of smartweed *(Polygonum puncta-tum)* in the habitat.

INTRODUCTION

Argiope aurantia Lucas is a common orb-weaving spider which occurs throughout the eastern part of the U.S., Central America, and along the west coast of North America (Levi 1968). It has been reported from a diversity of habitats including dense, perennial vegetation (Enders 1973); dry, grassy hillsides, margins of lakes, stream banks, near ponds, and sinks in swamps (Levi 1968).

While observations and work related to the general life habits, systematics, and distribution of *A. aurantia* and related species has been summarized by Levi (1968) and Comstock (1971), several workers have recently reported on various aspects of the biology of this species. Enders (1973, 1974, 1975, 1976, and 1977), Taub (1977), Uetz et al. 1978), and Brown (1981) have elucidated factors involved in web site selection, resource partitioning, and competitive interactions of *A. aurantia*. The predatory behavior of this spider has been described by Harwood (1974), and Robinson (1969) described the predatory behavior of *A. argentata*, a related and often competitive species (Enders 1974, Olive 1980, Brown 1981). Tolbert (1976) studied the population dynamics of these two species.

Although the diet of *A. aurantia* and *A. argentata* has received some attention (Robinson 1969, Robinson and Robinson 1970, Olive 1980, and Brown 1981) and while several laboratory studies have dealt with web building in *A. aurantia* and related spiders (Reed et al. 1969, Witt et al. 1972, and Ramousse 1973), no field study has focused on diet as it relates to development and no field study has followed both males and females of a

population from early instars to maturity. The objectives of the present field study were to document growth or developmental patterns of both males and females of the population, and to determine composition of diet of these spiders through one growing season.

HABITAT

The study area was the delta of Steel Creek, a system tributary to the Savannah River Swamp and within the boundaries of the Savannah River Plant, near Aiken, South Carolina. Beginning in the 1950's, this system was used to transport nuclear reactor cooling water to the Savannah River. Elevated water levels and temperatures denuded the area of its indigenous cypress forest and the accompanying canopy.

This study was done during the growing season of 1973, approximately six years after termination of the reactor cooling water discharge which supplied flood water and elevated temperatures. Therefore, the area was in a post-thermal successional stage and was characterized by dense stands of tall grasses, *Scirpus*, willows, myrtles, and small cypress trees. Water temperatures were ambient and water flow was widely dispersed over the entire area via small streams (usually < 1 meter in width). More detailed descriptions of this habitat can be found in Sharitz et al. (1974).

METHODS

Data for determining growth patterns of males and females were collected by randomly walking through one section of the habitat and collecting spiders as they were encountered. In the early portion of the study (early June), sex determination by sight was difficult, therefore, the first 50 individuals encountered were captured. Later, as the spiders matured, approximately 25 individuals of each sex were collected from the study area at two to three week intervals. Previous to collection of the spiders during a sampling effort, length and width of the webs were measured. Individuals were tagged and taken to the laboratory, where sex and physical data (wet weight, prosomal width, and opisthosomal length) were taken. Student-Newman-Keuls least significant range tests (Sokal and Rohlf 1969) were used to evaluate growth data for the populations through time.

Developmental classification and sex of the immatures were based upon Comstock (1971). For the purposes of this study, individuals with non-swollen pedipalpal tarsi and a banded leg color pattern were considered immature females; those with swollen pedipalpal tarsi and a banded leg color pattern were considered immature males; those with normal pedipalpal tarsi and solid black legs were considered mature females; and those with solid black legs and swollen, complex pedipalpal tarsi were considered mature males.

Data on prey items of *A. aurantia* were collected by following a consistent route through another section of the habitat. The sections involved were separated enough so that interference with the population in one would have no effect on the population in the other. At the beginning of a sampling effort, approximately 100 spider webs were marked by plastic ribbon tied to the bases of adjacent vegetation. Each sampling period for prey items consisted of three to four days each, depending upon weather. The trail was walked four times during a day (0800, 1030, 1300, and 1530 hours). Wrapped prey items were recovered from webs and identified at least to order.

RESULTS

Growth Characteristics vs. Web Area.—Figures 1A and 1B illustrate the changes in wet weight and web area through time for both males and females of the population. At the beginning of the study, spider webs were small, clumped into localized groups, placed low, and often at the edges of dense stands of vegetation. Wet weight of females accelerated beginning with Day 28 and was highest among sampled days on Day 64. SNK-LSR tests showed that wet weights of females collected for Days 1 and 14 were statistically indistinguishable as were wet weight of females collected for Days 64 and 90 (Table 1). Wet weight data for Day 43 were significantly different from all other female wet weight data sets. Web area recorded for these individuals, however, did not follow the same pattern. SNK-LSR tests indicated that web area for females collected for Day 14 was significantly smaller; web areas from Day 28 through Day 90, however, were not statistically different.

Wet weights of males did not change significantly after Day 14 (Table 1). Male webs tended to reverse the pattern observed for female webs by decreasing in area from Day 14 through Day 43.

Two other measurements of growth are illustrated in Figs. 1C and 1D. Female prosomal width increased through Day 64. Prosomal width for females of the population showed a statistically significant decrease at Day 90 (Table 1). Female opisthosomal length, however, peaked among sampling days at Day 64 and remained unchanged in the population through Day 90. Male prosomal width increased from Day 1 through Day 43, although prosomal data collected for males at Days 28 and 43 were not significantly different. Male opisthosomal length showed an increase between Days 1 and 14 and a decrease between Days 28 and 43. Day 43 data were not significantly different from Day 1 data; opisthosomal lengths from Days 14 and 28 were not different.

Observations on Sexual Maturity.—For females, Day 1 and 14 samples consisted entirely of immatures. Over 95% still showed immature female characteristics at Day 28. At Day 43, 36% were mature; and by Day 64, all were mature. Egg cases were first seen on Day 64; and by Day 90 over 50% of the webs examined had egg cases placed in supporting vegetation.

While 100% of the individuals collected at Day 1 for the male population were obviously immature, 10% showed mature male characteristics at Day 14. Seventy-eight percent of the males collected on Day 28 were mature. By Day 43, 100% of the males collected were mature. Males were not seen in the habitat following Day 43 of the study.

Males were first observed on female webs during the Day 28 sampling effort (seven of the 21 collected were on female webs). During the Day 43 collection, 15 of 27 were on female webs and 12 were "tending" their own webs. Also on Day 43, 13 of 25 female webs had males on the support threads. Sixteen of the 25 females still fit the criteria for immature females. Nine of the 16 were associated with mature males. It was not unusual during this collecting period to find four or five males on a given female web.

Diet.—Insect orders found as wrapped items in webs of female *A. aurantia* during the study are tabulated in Table 2 by percent occurrence. Since the collection of prey items from spider webs generally extended over a several day period and was not always strictly associated with the particular day that collections were made for growth data, the items are grouped in Table 1 according to the approximate Day of the study. Overall, prey item collections were divided into five major time spans, beginning with mid-July
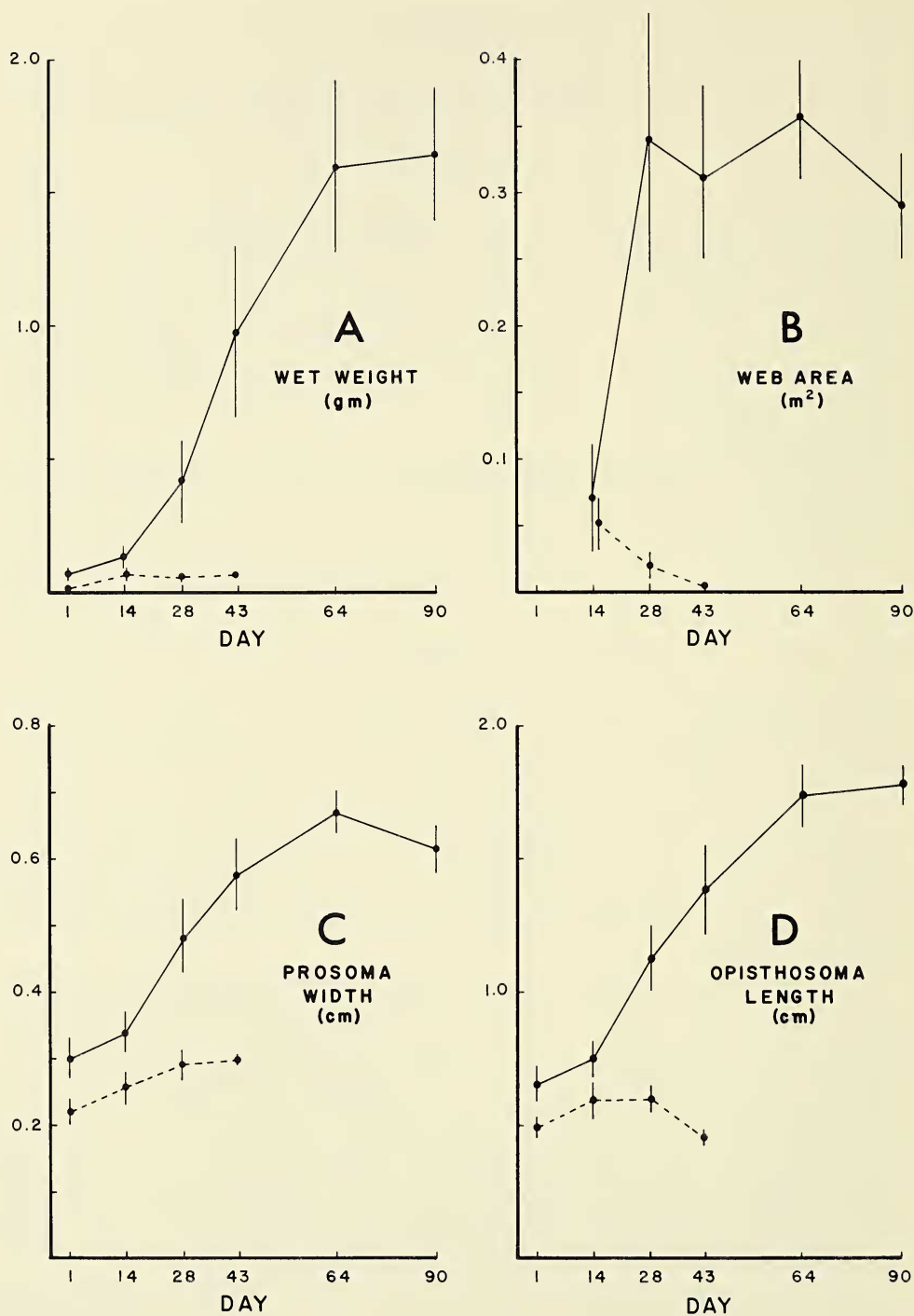
Fig. 1.—Means (± 2 SE) for wet weight of spiders (A), web area (B), prosomal width (C), and opisthosomal length (D) of *Argiope aurantia* collected at various time intervals during the study. Females = solid line; males = broken line; Day 1 = 27 June, Day 14 = 10 July; Day 28 = 24 July; Day 43 = 8 August; Day 64 = 29 August; and Day 90 = 24 September.

Table 1.–SNK-LSR tests for male and female growth parameters. Means connected by underlines are not significantly different at the 0.05 probability level.

Wet Weight:						
Female						
Day Rank	1	14	28	43	64	90
mean (gm)	.07	.13	.42	.97	1.60	1.64
Male						
Day Rank	1	28	43	14		
mean (gm)	.02	.06	.07	.07		
Web Area:						
Female						
Day Rank	14	90	43	28	64	
mean (m)	.07	.29	.31	.34	.36	
Male						
Day Rank	43	28	14			
Mean (m)	.004	.023	.048			
Prosomal Width:						
Female						
Day Rank	1	14	28	43	90	64
mean (cm)	.30	.34	.48	.58	.61	.67
Male						
Day Rank	1	14	28	43		
mean (cm)	.22	.26	.29	.30		
Opisthosomal Width:						
Female						
Day Rank	1	14	28	43	64	90
mean (cm)	.66	.75	1.14	1.40	1.74	1.79
Male						
Day Rank	43	1	14	28		
mean (cm)	.47	.49	.60	.60		

(Day 14 in Figure 1) and ending in mid-October (104th day of the study, i.e., approximately 2 weeks following Day 90 of Figure 1).

Data reported in Table 2 represent prey captures by female spiders. Only a few captures by males were recorded during the study. These were associated with Day 14 of Table 2 and consisted of three zygopterans, one anisopteran, one lepidopteran, and one acridid orthopteran.

Minor contributors to spider prey were mayflies and Diptera. These were found wrapped in webs early in the study (Table 2). Members of three insect orders (Orthoptera, Hemiptera, and Coleoptera) represented less than 12% of the total prey recovered from webs during any given sampling period. Lepidoptera accounted for 12 to 16% of the prey items per collection through late August (Day 64), but became relatively unimportant as prey items toward the end of the study.

Major contributors to prey recovered from spider webs belonged to the Odonata and Hymenoptera. Among the odonates, damselflies and dragonflies varied in importance early in the study. In mid-July samples (Day 14), damselflies accounted for more than 50% of the items collected; dragonflies assumed greater importance during the early and late August samples (Days 43 and 64), accounting for 28 to 30% of the prey items found

Table 2.—Percent occurrence of prey items found wrapped in *Argiope aurantia* webs. Numbers in parentheses relates day of study on which physical data for the population were taken to approximate time interval in which prey items were recovered from spider webs.

Insect Group:	% Occurrence				
	mid-July (14)	early Aug. (43)	late Aug. (64)	late Sept. (90)	mid-Oct. (104)
Ephemeroptera	2.7	0.6	0.0	0.0	0.0
Odonata					
Zygoptera	51.4	17.9	4.0	3.2	0.0
Anisoptera	13.5	30.3	28.0	3.2	7.7
Orthoptera	5.0	8.0	5.6	2.1	0.0
Hemiptera	8.0	6.8	11.2	7.5	3.9
Lepidoptera	16.2	15.4	12.8	4.2	0.0
Coleoptera	0.0	10.5	1.6	0.0	0.0
Diptera	0.0	1.2	0.8	0.0	0.0
Hymenoptera	0.0	8.0	35.2	79.8	88.5
Others	2.7	1.2	0.8	0.0	0.0
Total n	37	162	125	94	26

wrapped in the webs. The importance of odonates, however, declined sharply after August. Hymenoptera, particularly honeybees and bumblebees (Apidae) began to assume major importance as prey in late August and by the final two sampling periods accounted for 80 to 88% of the prey items recovered. *Polygonum punctatum* (smartweed), a dominant plant in the habitat, began flowering in late August and represented the major source of flowers for pollinating insects.

DISCUSSION

From literature reports it is unclear as to how comparable this study is to those of Enders (1974), Olive (1980), Tolbert (1976), and Brown (1981). Whereas these studies focused upon niche separation and resource partitioning among competitive species of *Argiope* and related species, our study dealt only with *A. aurantia.* Competitive species, as far as we know, did not occur in this post-thermal habitat. *Argiope trifasciata* was never seen and other orb-weaving species such as *Araneus*, if present at all, were not in significant numbers. This study, therefore, represents growth and development in a population of *A. aurantia* without a major influence of competitive species.

Growth and Sexual Development.—Based upon data collected in this study, several important events in the life history of *A. aurantia* occurred during the month between Day 14 and Day 43. Immature females at Day 28 had achieved only 22% of their mature weight yet had constructed webs with areas comparable to those of mature females collected later in the study. The increase was 4 fold over web area noted for females two weeks earlier. During the same time frame (Day 14 - 28), a portion of the male population was reaching sexual maturity and beginning to cease tending of their own webs as evidenced by data on male webs (Fig. 1B). By Day 28, males were invading female webs, and by Day 43, the entire male population was mature and had all but abandoned web

building. Copulations most likely occurred between Day 28 and a few days following Day 43 of our study. We did note that mature males occupied "immature" female webs, but were unable to establish when mating occurred between these individuals, or if males waited for the immatures to molt. Copulation was observed between two mature individuals.

Of the physical parameters taken in this study, prosomal width was probably the most direct measurement of growth. Prosomal width data sets for females were statistically different, regardless of sampling period and indicates a consistent growth sequence for females through Day 64. However, since maturity was apparently reached by the majority of the female population by Day 64, the decease in female prosomal width at Day 90 is an indication that some females matured later and at a smaller size than others in the population. This phenomenon has been suggested by Benforado and Kistler (1973) for *Araneus diadematus* and by Brown (1981) for *Argiope aurantia* and related species. These workers found that weight and development is at least partially related to trapping success.

Male prosomal width, however, did not follow this pattern, and our data indicate that most of the males had reached maturity by Day 28. A decrease in variation associated with prosomal width of males at Day 43 is probably a measure of the degree of maturation within the males at that point in the growing season. The decrease in opisthosomal lengths of males from Day 28 to Day 43 may be an indication of a lack of feeding and consumption of stored energy reserves.

Diet.—The overall composition of *A. aurantia*'s diet observed in this study parallels that found by other workers, although diet may vary in detail. Brown (1981), for example, recorded major differences in the diets of two populations of *A. aurantia*. Dragonflies (Aeshnidae) were important contributors to the diet of spiders in a shoreline habitat; Apidae were more important in the diets of spiders in a grassland environment. Acrididae were dominant contributors in both areas. Also, although prey availability is important, Olive (1980) has shown that *A. trifasciata*'s biomass intake is substantially enhanced by selection of less frequent but larger bodied insects, particularily pollinating Apidae and Vespidae. Neither study, however, associated spider growth with composition of diet.

Our data show two major shifts in diet composition. The first occurred as a result of a change in immature female behavior which, in turn, paralleled the appearance of mature males in the population. The dramatic increase in female web area between Days 14 and 28 apparently placed the immature females into insect flyways and provided larger prey items. Although we did not record web heights, other workers have noted sudden increases in web size and height in this and related species (Enders 1974, Olive 1980, Brown 1981). In our study, Day 14 prey consisted mainly of damselflies, which tended to aggregate low in the vegetation. By Day 28, however, the webs were larger and placed either higher or in more open areas (spanning small streams). With this change in web placement, diet composition consisted primarily of larger bodied, libellulid dragonflies.

A second major shift in prey composition occurred just previous to egg case production and appeared to be associated with changes within the habitat. As one of the dominant plants *(P. punctatum)* began flowering, pollinating insects began appearing in greater frequency in *A. aurantia* webs. A similar shift in prey composition of *A. trifasciata* and *Araneus trifolium* as it related to habitat changes was noted by Olive (1980). In that study, large numbers of Apinae and Vespinae became prey items as *Solidago* in the habitat came into bloom.

ACKNOWLEDGMENTS

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